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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : D01F 8/14, D04H 3/14	A1	(11) International Publication Number: WO 00/66821 (43) International Publication Date: 9 November 2000 (09.11.00)

(21) International Application Number: PCT/US00/10705

(22) International Filing Date: 20 April 2000 (20.04.00)

(30) Priority Data:
09/303,805 30 April 1999 (30.04.99) US

(71) Applicant: KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 North Lake Street, Neenah, WI 54956 (US).

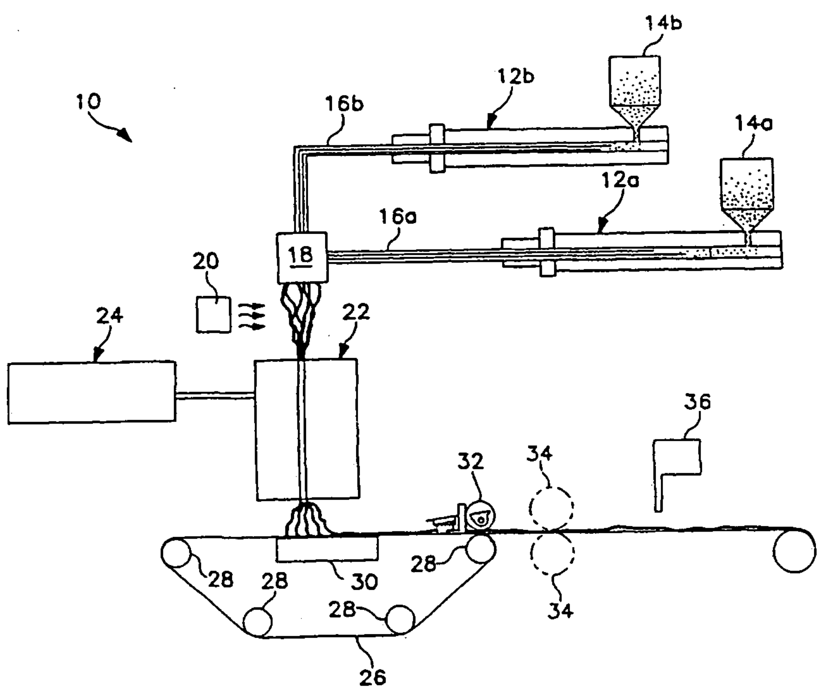
(72) Inventors: HANCOCK-COOKE, Catherine, Marguerite; 216 Bosworth Court, Neenah, WI 54956 (US). NEELY, James, Richard; 3585 Waters Cove Way, Alpharetta, GA 30202 (US).

(74) Agents: FEJER, Mark, E.; Pauley Petersen Kinne & Fejer, Suite 365, 2800 West Higgins Road, Hoffman Estates, IL 60195 (US) et al.

(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: STRETCHABLE NONWOVEN MATERIAL



(57) Abstract

A stretchable nonwoven material including a nonwoven web comprising a plurality of bicomponent fibers comprising a polyester and a second polymer, said nonwoven web having been pattern-bonded or point-bonded followed by heating after forming. The second polymer is preferably a polyolefin, such as polyethylene or polypropylene.

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STRETCHABLE NONWOVEN MATERIAL

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a nonwoven material which exhibits elastomeric properties although containing no thermoplastic elastomers or rubbers. More particularly, this invention relates to a nonwoven material that is stretchable in a machine direction and/or a cross direction without the use of thermoplastic elastomers or rubbers. The nonwoven material exhibits elastic recovery in both the machine direction and the cross direction when stretched up to about 30%. The material is particularly suitable for use in personal care absorbent articles such as diapers, training pants and adult incontinence garments.

Description of Prior Art

Absorbent personal care articles such as sanitary napkins, disposable diapers, incontinent-care pads and the like are widely used, and much effort has been made to improve the effectiveness and functionalities of these articles. Thick, flat personal care articles of the past that do not fit the shape of the human body and do not conform to the movements of the user have been largely replaced by resiliently conforming 3-dimensional, body-shaped articles.

Nonwoven webs are defined as webs having a structure of individual fibers or threads which are interlaid, but not in a regular or identifiable manner, as in a knitted fabric. Nonwoven webs can be formed by many processes such as, for example, meltblowing processes, spunbonding processes, and bonded carded web processes. Typically, the fibers from these processes are deposited onto a forming wire or belt for formation of the web. When subjected to heat following formation of the web, there is a tendency for the nonwoven web to shrink. Shrinkage of the nonwoven web is considered to be disadvantageous in that it generally results in non-uniformity of the web. See for example, U.S. Patent 5,382,400 and U.S. Patent 5,418,045, both to Pike et al., which teach a process for making nonwoven polymeric fabrics wherein continuous meltspun multicomponent polymeric filaments are crimped before the continuous multicomponent filaments are formed into a nonwoven web, resulting in a substantial reduction in shrinkage and a substantially stable and uniform nonwoven web.

It will be apparent, however, that diapers, training pants and incontinence garments made from substantially stable, uniform nonwoven webs may not conform to the movement of the wearer, reducing the comfort, and possibly the functionality, of the articles. To date, as indicated hereinabove, this issue has been addressed by resiliently conforming 3-dimensional, body-shaped articles as well as articles employing elastic films.

SUMMARY OF THE INVENTION

It is one object of this invention to provide a nonwoven web material which exhibits elastic properties.

It is another object of this invention to provide a nonwoven web material which exhibits elastic properties and which does not employ any thermoplastic elastomers or rubbers.

These and other objects of this invention are addressed by a stretchable nonwoven material comprising a nonwoven web comprising a plurality of bicomponent fibers comprising a polyester and a second polymer, said nonwoven web, after formation thereof, having been pattern-bonded or point-bonded and then heated. Suitable polyesters for use in this invention are any polyesters which shrink upon being heated. In accordance with one particularly preferred embodiment, the polyester is polyethylene terephthalate (PET). The second polymer is one which does not shrink as much as the polyester upon heating, preferably a polyolefin or a polyamide. The resulting stretchable nonwoven material is stretchable up to about 130% of its unbiased length in the machine direction and/or the cross machine direction. Upon release of the bias force, the nonwoven material exhibits elastic recovery in both the machine direction and the cross direction, returning substantially to its original dimensions. Depending upon the polyester and second polymer used to form the fibers, the fibers can be made to split.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of this invention will be better understood from the following detailed description taken in conjunction with the drawings wherein:

Fig. 1 is a schematic diagram of a process line for producing a stretchable nonwoven material in accordance with this invention; and

Fig. 2 is a table showing the results obtained from materials produced in accordance with the method of this invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Definitions

The term "stretchable" is used herein to mean any material which, upon application of a biasing force, is elongatable, to a stretched, bias length and which will recover at least 50% of its elongation upon release of the stretching, elongating force. A hypothetical example would be a one (1) inch sample of a material which is elongatable to at least 1.50 inches (50% elongation) and which, upon being elongated to 1.50 inches and released, will recover to a length of not more than 1.25 (50% recovery) inches.

As used herein, the term "nonwoven web" or "nonwoven material" means a web having a structure of individual fibers or threads which are interlaid, but not in a regular or identifiable manner, as in a knitted fabric and films that have been fibrillated. Nonwoven webs or materials have been formed from many processes such as, for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven webs or materials is usually expressed in ounces of material per square yard (osy) or grams per square meter (gsm), and the fiber diameters usable are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91.)

As used herein, the term "spunbond fibers" refers to small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret with a diameter of the extruded filaments then being rapidly reduced as taught, for example, by U.S. Patent 4,340,563 to Appel et al., U.S. Patent 3,692,618 to Dorschner et al., U.S. Patent 3,802,817 to Matsuki et al., U.S. Patent 3,338,992 and U.S. Patent 3,341,394 to Kinney, U.S. Patent 3,502,763 to Hartmann, U.S. Patent 3,502,538 to Levy, and U.S. Patent 3,542,615 to Dobo et al. Spunbond fibers are quenched and generally not tacky when they are deposited onto a collecting surface. Spunbond fibers are generally continuous and have average diameters larger than 7 microns, more particularly, between about 10 and 35 microns.

As used herein, the term "meltblown fibers" refers to fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into converging high velocity gas streams (for example, airstreams) which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface

to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, for example, by U.S. Patent 3,849,241 to Butin. Meltblown fibers are microfibers which may be continuous or discontinuous, are generally smaller than 10 microns in average diameter, and are generally tacky when deposited onto a collecting surface.

As used herein, the term "bonded carded web" refers to webs made from staple fibers which are sent through a combing or carding unit, which breaks apart and aligns the staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. Such fibers are usually purchased in bales which are placed in a picker which separates the fibers prior to the carding unit. Once the web is formed, it is then bonded by one or more of several known bonding methods.

As used herein, the term "microfibers" refers to small diameter fibers having an average diameter not greater than about 75 microns, for example, having an average diameter of from about 0.5 microns to about 50 microns, or more particularly, having an average diameter of from about 2 microns to about 40 microns. Another frequently used expression of fiber diameter is denier, which is defined as grams per 9000 meters of a fiber, and may be calculated as fiber diameter in microns squared, multiplied by the density in grams/cc, multiplied by 0.00707. A lower denier indicates a finer fiber and a higher denier indicates a thicker or heavier fiber. For example, a diameter of a polypropylene fiber given as 15 microns may be converted to denier by squaring, multiplying the results by 0.89 g/cc and multiplying by 0.00707. Thus, a 15 micron polypropylene fiber has a denier of about 1.42. Outside the United States, the unit of measurement is more commonly the "tex", which is defined as the grams per kilometer of fiber. Tex may be calculated as denier/9.

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" also includes all possible geometric configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic, atactic and random symmetries.

As used herein, the term "personal care article" means disposable diapers, training pants, absorbent underpants, adult incontinence products, and feminine hygiene products.

As used herein, the term "bicomponent fibers" refers to fibers which have been formed from at least two polymers extruded from separate extruders but spun together to form one fiber. Bicomponent fibers are also sometimes referred to as conjugate fibers or multicomponent fibers. The polymers are arranged in substantially constantly positioned distinct zones across the cross-sections of the bicomponent fibers and extend continuously along the length of the bicomponent fibers. The configuration of such a bicomponent fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another, or may be a side-by-side arrangement, a pie arrangement, or an "islands-in-the-sea" arrangement. Bicomponent fibers are taught by U.S. Patent 5,108,820 to Kaneko et al., U.S. Patent 4,795,668 to Krueger et al., U.S. Patent 5,540,992 to Marcher et al., and U.S. Patent 5,336,552 to Strack et al. Bicomponent fibers are also taught by U.S. Patent 5,382,400 to Pike et al. For two component fibers, the polymers may be present in ratios of 75/25, 50/50, 25/75 or any other desired ratio.

As used herein, the term "machine direction" or "MD" means the length of a fabric in the direction in which it is produced. The term "cross machine direction" or "CD" means the width of fabric, that is a direction generally perpendicular to the MD.

As used herein, the term "consisting essentially of" does not exclude the presence of additional materials which do not significantly affect the desired characteristics of a given composition or product. Exemplary materials of this sort would include, without limitation, pigments, antioxidants, stabilizers, surfactants, waxes, flow promoters, solvents, particulates, and materials added to enhance processability of the composition.

The invention disclosed herein is a nonwoven material that exhibits elastomeric properties although it contains no thermoplastic elastomers or rubbers. The material comprises a nonwoven web made of bicomponent fibers containing a polyester and a second polymer, such as polyethylene. When the web is pattern-bonded or point-bonded and exposed to a heating process subsequent to being bonded, it shrinks, resulting in a nonwoven material that exhibits elastic recovery in both the machine direction and the cross direction when stretched up to about 30%. The nonwoven web is preferably heated to a temperature of at least about 220°F. The amount of stretch and recovery is adjustable by varying the "shrinkage" temperature, and/or bond area and/or polyester content. In addition, the amount of shrinkage increases as the basis weight of the nonwoven web increases.

Fig. 1 is a schematic diagram of a process line for producing a stretchable nonwoven material in accordance with this invention. The process line 10 is arranged to produce bicomponent continuous filaments. The process line 10 includes a pair of extruders 12a and 12b for separately extruding a polymer component A, a polyester in the instant case, and a polymer component B, for example a polyolefin. Polymer A is fed into the respective extruder 12a from a first hopper 14a and polymer component B is fed into the respective extruder 12b from a second hopper 14b. Polymer components A and B are fed from extruders 12a and 12b through respective polymer conduits 16a and 16b to a spinneret 18. Spinnerets are well known to those skilled in the art and, thus, will not be described in detail herein. Generally, the spinneret 18 includes a housing containing a spin pack which includes a plurality of plates stacked one on top of the other with a pattern of openings arranged to create flow paths for directing polymer A and polymer B separately through the spinneret. The spinneret 18 has openings arranged in one or more rows. The spinneret openings form a downwardly extending curtain of filaments when the polymers are extruded through the spinneret. For purposes of the present invention, the spinneret 18 is arranged so as to form bicomponent filaments wherein both polymer A and polymer B are disposed on a portion of the surface thereof. Such bicomponent filaments include side-by-side arrangements, pie arrangements and polylobal arrangements in which one of the polymers forms at least a portion of the lobes, which lobes are disposed at a distance from one another, and the second polymer is centrally disposed, at least a portion of the surface of which can be seen in the area between the lobes.

The process line 10 also includes a quench blower 20 positioned adjacent to the curtain of filaments extending from spinneret 18. Air from the quench air blower 20 quenches the filaments extending from spinneret 18.

A fiber draw unit or aspirator 22 is disposed below spinneret 18 and receives the quenched filaments. Fiber draw units or aspirators for use in meltspinning polymers are well known to those skilled in the art. Suitable fiber draw units for use in this process include a linear fiber aspirator of the type shown in U.S. Patent 3,802,817 and eductive guns of the type shown in U.S. Patents 3,692,618 and 3,423,266, the disclosures of which are incorporated herein by reference.

Generally described, fiber draw unit 22 includes an elongated vertical passage through which the filaments are drawn, aspirating air entering from the sides of the passage

and flowing downward through the passage. Heater 24 supplies hot aspirating air to fiber draw unit 22. The hot aspirating air draws the filaments and ambient air through fiber draw unit 22.

An endless foraminous forming surface 26 is positioned below fiber draw unit 22 and receives the continuous filaments from the outlet opening of fiber draw unit 22. The forming surface 26 travels around guide rollers 28. A vacuum 30 positioned below the forming surface 26 where the filaments are deposited draws the filaments against the forming surface.

The process line 10 further comprises compression roller 32 which, along with the forwardmost of the guide rollers 28, receive the web as it is drawn off of the forming surface 26. In addition, process line 10 further includes a bonding apparatus such as pattern bonding, or thermal point bonding, 34.

Thermal point bonding involves passing a fabric or web of fibers to be bonded between a heated calender roll and an anvil roll. The calender roll is usually, though not always, patterned in some way so that the entire fabric is not bonded across its entire surface. As a result, various patterns for calender rolls have been developed for functional as well as aesthetic reasons. One example of a pattern has points and is the Hansen Pennings or "H&P" pattern with about a 30% bond area with about 200 bonds/square inch as taught in U.S. Pat. No. 3,855,046 to Hansen and Pennings. The H&P pattern has square point or pin bonding areas wherein each pin has a side dimension of 0.038 inches (0.965 mm), a spacing of 0.070 inches (1.778 mm) between pins, and a depth of bonding of 0.023 inches (0.584 mm). The resulting pattern has a bonded area of about 29.5%. Another typical point bonding pattern is the expanded Hansen and Pennings or "EHP" bond pattern which produces a 15% bond area with a square pin having a side dimension of 0.037 inches (0.94 mm), a pin spacing of 0.097 inches (2.464 mm) and a depth of 0.039 inches (0.991 mm). Another typical point bonding pattern designated "714" has square pin bonding areas wherein each pin has a side dimension of 0.023 inches, a spacing of 0.062 inches (1.575 mm) between pins, and a depth of bonding of 0.033 inches (0.838 mm). The resulting pattern has a bonded area of about 15%. Yet another common pattern is the C-Star pattern which has a bond area of about 16.9%. The C-Star pattern has a cross-directional bar or "corduroy" design interrupted by shooting stars. Other common patterns include a diamond pattern with repeating and slightly

offset diamonds and a wire weave pattern looking as the name suggests, e.g., like a window screen.

Downstream of thermal point bonding rollers 34 is a hot air knife 36, or some other heating process, such as an oven, for heating the web to a desired temperature. A conventional hot air knife includes a mandrel with a slot that blows a jet of hot air onto the nonwoven web surface. Such hot air knives are taught, for example, by U.S. Patent 4,567,796 to Kloehn et al. Alternatively, the material can be laundered, is washed and dried at elevated temperatures to obtain the desired shrinkage.

As previously indicated, the nonwoven web used to make the nonwoven material of this invention comprises a plurality of bicomponent fibers containing a polyester and a second polymer, such as polyethylene. Although any polyester that shrinks upon heating may be used, in accordance with one particularly preferred embodiment, the polyester is polyethylene terephthalate. The second polymer comprising the bicomponent fibers is a polymer selected from the group consisting of polyolefins and polyamides. Particularly preferred polyolefins are polyethylene and polypropylene. Suitable polyamides include, but are not limited to, nylon 6, nylon 6/6, nylon 10, nylon 12 and the like.

Depending upon the selection of the polyester and the second polymer used to form the bicomponent fibers, the fibers can be rendered splittable, thereby enhancing the softness of nonwoven materials produced from them. These fibers can be split by any number of mechanical, thermal or chemical means. And, although splitting of the bicomponent fibers is not required for shrinkage of the nonwoven web during formation and for elastomeric recovery of the formed nonwoven web, it may increase the elastomeric characteristics of the material.

In accordance with one preferred embodiment of this invention, the bicomponent filament comprises in a range of about 40% by weight to about 90% by weight of polyester (PET). In accordance with a particularly preferred embodiment of this invention, the bicomponent filament comprises in a range of about 55% by weight to about 65% by weight of polyester.

The stretchable nonwoven material of this invention in accordance with one embodiment of this invention comprises bicomponent filaments which are produced by a bonded carded web process. In accordance with a particularly preferred embodiment, the bicomponent filaments used to produce the nonwoven web are spunbonded.

Examples

Fig 2 is a summary of data collected in connection with stretchable nonwovens produced in accordance with the method of this invention. Data is presented for five sample materials produced from side-by-side bicomponent fibers of PET and low linear density polyethylene, samples numbered 1-5. Two sets of data are presented for each sample — machine direction (MD) stretchability and cross direction (CD) stretchability. Process conditions for preparation of these samples were as follows:

Polymers:

PET=	Ticona EKX-183
LLDPE=	Dow 6811A
HDPE=	Dow 25455

Hole Diameter =	0.6 mm
Throughput =	0.6 ghm
Melt Temperature =	525°
Quench Air Temp =	61°F
Polymer Ratio =	50/50 (by volume) or 59/41 PET/PE (by weight)
Bond Pattern =	see examples (5% and 10% spirals, and HP)

Data for a 16 piece splittable pie configured bicomponent fiber nonwoven web, Sample 6, is also presented. In this case the bicomponent fibers were produced from PET and high density polyethylene (HDPE).

While in the foregoing specification this invention has been described in relation to certain preferred embodiments thereof, and many details have been set forth for purpose of illustration, it will be apparent to those skilled in the art that the invention is susceptible to additional embodiments and that certain of the details described herein can be varied considerably without departing from the basic principles of the invention.

WE CLAIM:

1. A stretchable nonwoven material comprising:

a nonwoven web comprising a plurality of bicomponent fibers comprising a polyester and a second polymer, said nonwoven web having been bonded by a method selected from the group consisting of pattern-bonding, point-bonding and combinations thereof and then heated.

2. A stretchable nonwoven material in accordance with Claim 1, wherein said polyester is a polyester that shrinks upon being heated.

3. A stretchable nonwoven material in accordance with Claim 2, wherein said second polymer is a polymer that shrinks less than said polyester upon being heated.

4. A stretchable nonwoven material in accordance with Claim 2, wherein said polyester is polyethylene terephthalate.

5. A stretchable nonwoven material in accordance with Claim 1, wherein said bicomponent fibers are configured such that both of said polyester and said second polymer are present on a surface of said fibers.

6. A stretchable nonwoven material in accordance with Claim 5, wherein said bicomponent fibers are configured as one of a side-by-side, polylobal, and pie arrangement.

7. A stretchable nonwoven material in accordance with Claim 1, wherein said polyester comprises in a range of about 20% to about 90% by weight of said bicomponent fibers.

8. A stretchable nonwoven material in accordance with Claim 1, wherein said polyester comprises in a range of about 40% by weight to about 65% by weight of said bicomponent fibers.

9. A stretchable nonwoven material in accordance with Claim 1, wherein said bicomponent fibers are spunbond.

10. A stretchable nonwoven material in accordance with Claim 1, wherein said second polymer is a polymer selected from the group consisting of polyolefins and polyamides.

11. A stretchable nonwoven material in accordance with Claim 10, wherein said second polymer is selected from the group consisting of polyethylene, polypropylene and nylon.

12. A stretchable nonwoven material in accordance with Claim 1, wherein said bicomponent fibers are splittable.

13. A method for producing a stretchable nonwoven material comprising the steps of:

forming a nonwoven web using a plurality of bicomponent fibers, said bicomponent fibers comprising a polyester and a second polymer;

bonding said nonwoven web using a method selected from the group consisting of pattern-bonding, point-bonding and combinations thereof; and

heating said nonwoven web, resulting in a stretchable nonwoven web.

14. A method in accordance with Claim 13, wherein said polyester is polyethylene terephthalate.

15. A method in accordance with Claim 13, wherein said second polymer is a polymer selected from the group consisting of polyolefins and polyamides.

16. A method in accordance with Claim 13, wherein said bicomponent fibers are spunbond.

17. A method in accordance with Claim 13, wherein said polyester comprises in a range of about 20% by weight to about 90% by weight of said bicomponent fibers.

18. A method in accordance with Claim 13, wherein said polyester comprises in a range of about 40% to about 65% by weight of said bicomponent fibers.

19. A method in accordance with Claim 13, wherein said bicomponent fibers are configured such that both of said polyester and said second polymer are present on a surface of said fibers.

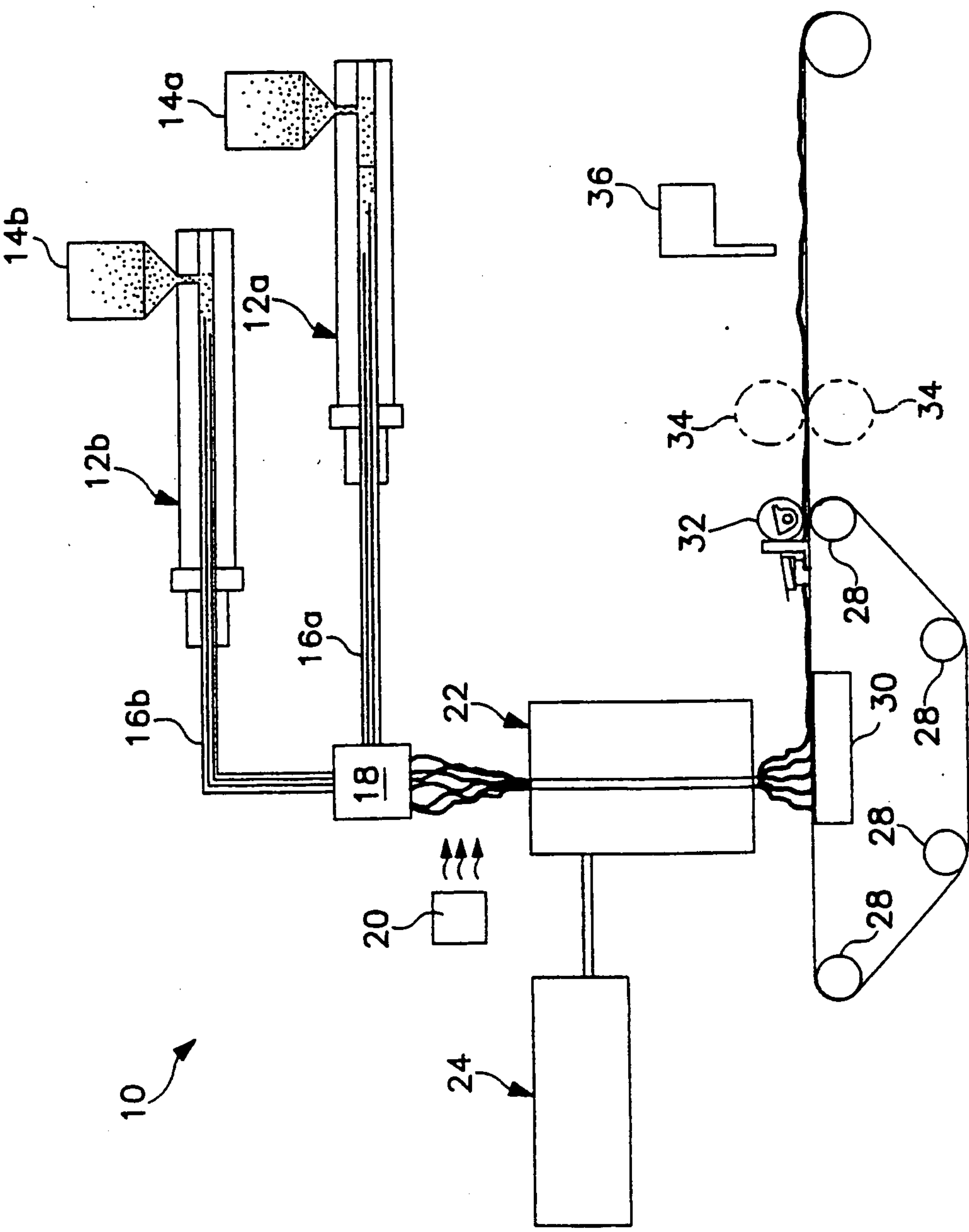
20. A method in accordance with Claim 19, wherein said bicomponent fibers are configured as one of a side-by-side, polylobal, and pie arrangement.

21. A method in accordance with Claim 15, wherein said polyolefin is selected from the group consisting of polyethylene and polypropylene.

22. A method in accordance with Claim 15, wherein said polyamide is nylon.

23. A personal care article comprising:

a nonwoven web comprising a plurality of bicomponent fibers comprising a polyester and a second polymer, said nonwoven web having been bonded by a method selected from the group consisting of pattern-bonding, point-bonding and combinations thereof, and then heated after formation.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12a
12b
14a
14b
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16b
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34
36

FIG. 1

SAMPLE	BASIS WEIGHT		HYDROENTANGLED	BONDED PATTERN		% SHRINKAGE	% EXTENSIBLE	% RECOVERY
SIDE BY SIDE PET/LLDPE								
1	2.5 osy		UNENTANGLED	5% SPIRAL	MD	NO DATA	30	100
1	2.5 osy		UNENTANGLED	5% SPIRAL	CD	26	40	100
2	2.5 osy		UNENTANGLED	5% + HP	MD	11	13	85
2	2.5 osy		UNENTANGLED	5% + HP	CD	9	22	78
3	2.5 osy		2 PASSES	5% + HP	MD	14.8	30	90
3	2.5 osy		2 PASSES	5% + HP	CD	9.8	25	80
4	2.5 osy		2 PASSES	10% SPIRAL	MD	33	20	80
4	2.5 osy		2 PASSES	10% SPIRAL	CD	20	25	68
5	2.5 osy		2 PASSES	10% SPIRAL	MD	35	20	60
5	2.5 osy		2 PASSES	10% SPIRAL	CD	20	30	100
16 PIECE SPLITTABLE PIE PET/HDPE								
6	2.6 osy		2 PASSES	HP	MD	22	28	71
6	2.6 osy		2 PASSES	HP	CD	13	10	100

FIG. 2

INTERNATIONAL SEARCH REPORT

Int .tional Application No
PCT/US 00/10705

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D01F8/14 D04H3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 814 569 A (FUKUI HIROAKI ET AL) 29 September 1998 (1998-09-29) column 8, line 4 -column 9, line 29; example 1	1-11, 13-23
Y	EP 0 905 292 A (KANEBO LTD) 31 March 1999 (1999-03-31) page 3, line 15 - line 38 page 15, line 25 - line 47 page 7, line 21 - line 27	1-11, 13-23
A	EP 0 757 127 A (POLYMER PROCESSING RES INST ;NIPPON PETROCHEMICALS CO LTD (JP)) 5 February 1997 (1997-02-05) page 5, line 6 -page 6, line 3 page 8, line 56 -page 9, line 50	1-22

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[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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